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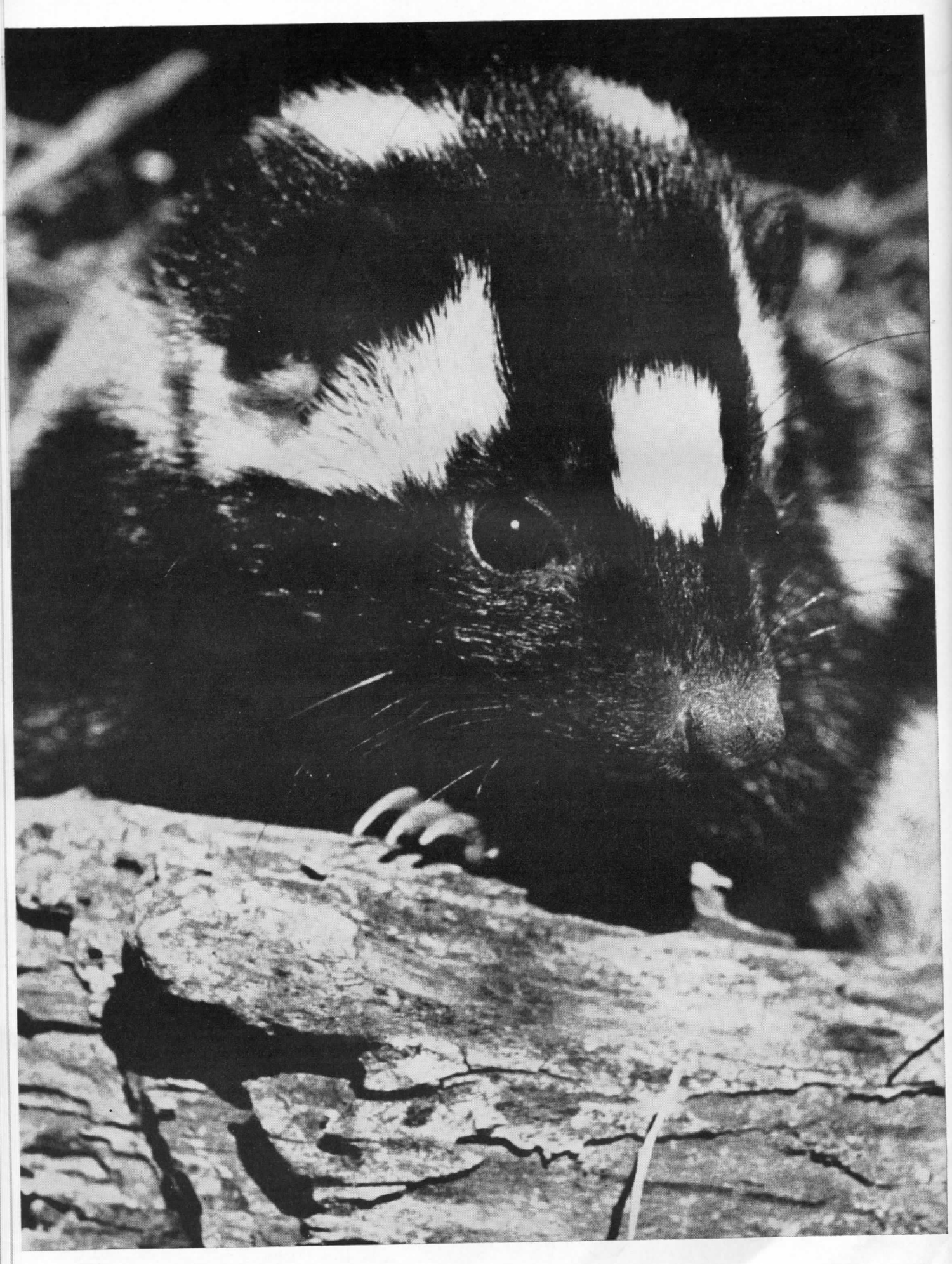


Channel Island Skunk

Geological changes may have had influence on animal's speciation

By Richard G. Van Gelder

As laboratories for the study of evolution, islands have had a special appeal to biologists. The evolutionary theories of Darwin and Wallace were initiated by observation of insular animals and plants in the Galápagos and the East Indies, and in the past hundred years biologists have continued to take advantage of special study opportunities presented by island isolation. Is an island animal different from its relatives on the mainland? How different is it? How did it get to the island? How long has it been there? How much change has taken place since its arrival and isolation?

More often than not, the answers to these questions are not readily apparent. In fact, it is frustrating to have many of them remain unanswered, but it is also stimulating to speculate—to follow the hypotheses formulated from the "if" stage to the "therefore," and to see if the observations fit any hypothesis. If they do, the hypothesis becomes theory.

Skunks are strictly Western Hemisphere animals, and the three major types are found in various localities from northern Canada all the way to Patagonia. The spotted skunk (*Spilogale putorius*) is found from the southern border of Canada southward to Costa Rica, and from coast to coast except in the northeastern United States. A closely related species, the pygmy skunk (*S. pygmaea*), is found solely on the western coast of Mexico from Sinaloa to Oaxaca, and it measures only ten inches from tip of nose to tip of tail. The spotted skunk, with a range of some 3,500 miles from north to south and 2,500 miles from east to west on the mainland, is found off the California coast only on Santa Rosa and Santa Cruz, the two larger islands of the Santa Barbara group of the Channel Islands.

Santa Cruz and Santa Rosa are the only islands inhabited by the spotted skunk. It has a wide range on mainland.

The Channel Islands include Santa Catalina, the most famous, San Clemente, San Nicolas, and Santa Barbara, which form the southernmost, or Santa Catalina, group. To the north, about twenty-five miles south of the edge of Santa Barbara County, is another string of islands—Anacapa, Santa Rosa, Santa Cruz, and San Miguel—known as the Santa Barbara group.

There are three broad possibilities to account for the presence of spotted skunks on these islands. First, they could have swum to them or been carried to them accidentally on a log or a bit of floating debris; second, they could have been transported by man, recent or primitive; third, they could have walked at a time when the islands were connected to the mainland.

Let us examine these possibilities to see if any may be eliminated. Spotted skunks can swim, but it seems unlikely that they could manage to swim the ten to thirty miles of ocean that would have made it possible for them to reach the islands. Further, spotted skunks seem to have trouble crossing a water barrier of even a few hundred yards. For example, they have not crossed the Fraser River in British Columbia or the Potomac River drainage in Pennsylvania. The Mississippi River between Illinois and Iowa seems to work as an effective barrier, and it is only within the last few decades that they have managed to cross that river where it narrows farther north, between Minnesota and Wisconsin. Further, spotted skunks occur on the coasts of North America near other islands, but they do not live on any of them. In the more than 1,500 miles of coastline of Baja California, Mexico, there are islands close to shore and spotted skunks on the peninsula, yet these animals do not exist on the islands. Thus it would seem that the possibility of their swimming the many miles necessary to reach the Channel Islands is remote.

The second possibility is rafting. Could the skunks have been carried to the islands by accident on a pile of debris washed offshore and carried by ocean currents to the islands? This cannot be ruled out. If they arrived on the islands in this fortuitous manner, there is no way of determining when it occurred. Let us admit this manner of invasion is possible and continue with other hypotheses.

Could the Indians or even the early white settlers have brought these animals to the islands? It is possible but not too probable. To the best of knowledge, the Indians did not make pets of skunks, and even if they had done so, they would more likely have chosen the more docile, tractable striped skunk. The transporting of a non-descented skunk (and there are no data to indicate that the Indians knew how to remove the scent sacs) to the islands would scarcely have been a pleasant affair, and in general would have been an unlikely undertaking. There is also no evidence that the early white settlers deliberately moved skunks to the islands. Of course, the possibility exists that the animals accidentally stowed away on a boat, but this, again, is a very remote possibility.

There is yet another suggestion. Geologists tell us that early in the Pleistocene the Santa Barbara Channel Islands were connected with the mainland, because at that time the land was uplifted in that area. The fossil record shows that spotted skunks existed then, roughly one million years ago, and they could have walked to the place where the islands now are. Structurally, the islands are a part of the Santa Monica Mountains in Los Angeles County, and spotted skunks are still found on the mainland portion of the range. The subsequent geological changes that took place produced a water barrier that has separated the islands from the mainland ever since.

Although none of the other suggestions for the occupation of the islands that we have discussed can be eliminated completely from our thinking, the last one—that they walked across when the islands were connected with the mainland—requires the least effort on the part of the animals, and it, there-

fore, seems by far the most probable.

Assuming that the spotted skunks have been on the islands for nearly a million years, we might be able to discover something of how much they have evolved by comparing them with the spotted skunks that now live on the mainland. The island skunks differ notably from those on the adjacent mainland in two ways—the tail is shorter and the face is broader. To the taxonomist these slight differences are not sufficient to warrant the separation of the two at the species level. At present, the spotted skunks on the islands are regarded as a "weak" subspecies and bear the name *Spilogale putorius amphiala;* those on the adjacent mainland are *S. putorius phenax.*

A statistical analysis gives assurance that character differences between these two groups are real, not haphazard. The average size of any one character, such as length of tail or breadth of skull, will be different in any two samples, even if they are drawn from the same population, and in the present case the statistical techniques indicate that there is only one chance in a hundred that these measurable differences—the shorter tail and the broader face—are errors in the sampling. Even so, the differences are not great. For example, the average length of the tail in males of Santa Cruz Island skunks is 128 mm. In the Los Angeles County skunks, it is 158 mm.—less than an inch of difference. The facial breadth (measurement across the zygomatic arches of the skull) averages 38 mm. in the island skunks and 36 mm. in those from the mainland; the interorbital breadths are 16.5 and 15.7 mm., respectively.

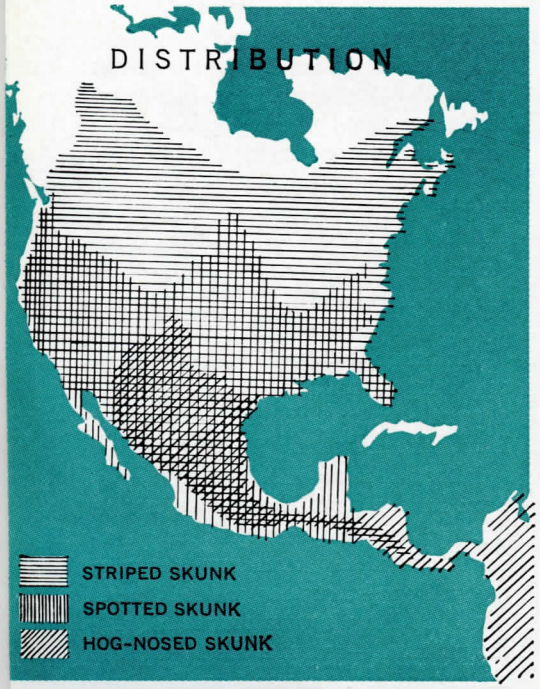
Even in color pattern the differences are slight. The underside of the tail of the insular spotted skunks is generally less than half-white—the average is 45 per cent; the underside of the tail in the mainland skunks averages 55 per cent half-white.

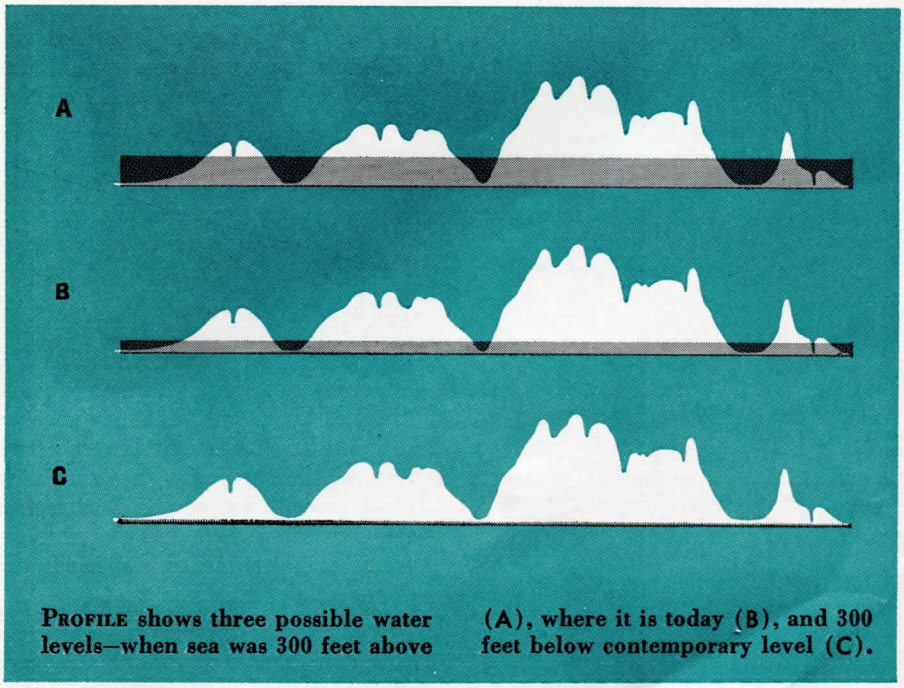
With the establishment of the differences between the mainland and island skunks, another question immediately comes to mind—how different are the skunks on Santa Rosa Island from those on Santa Cruz, and how long have they been separated? After separation from the mainland, the islands may have been connected with one another or may have separated, depending upon the fluctuations of the sea level and the geologic uplift of the area. If the water level were dropped 300 feet from its present level, all four of the islands would form a single unit, but they would still be separated from the mainland by more than ten miles of water. The depth of the Santa Barbara Channel between Santa Rosa and the mainland reaches 1,500 feet.

During the glacial periods, the withdrawal of ocean water to form the ice is believed to have lowered the sea level about 300 feet during the last (Wisconsin) glaciation. That would be the last time that the skunks on Santa Rosa and Santa Cruz Islands could have been in contact, and interbred. It is estimated that the rising water level at the end of the Wisconsin would have separated the skunks on the two islands about 8,000 years ago. The island skunks are more similar to each other than they are to those on the mainland, which fits the hypothesis that they walked over and then were separated—first from the mainland, and then from each other.

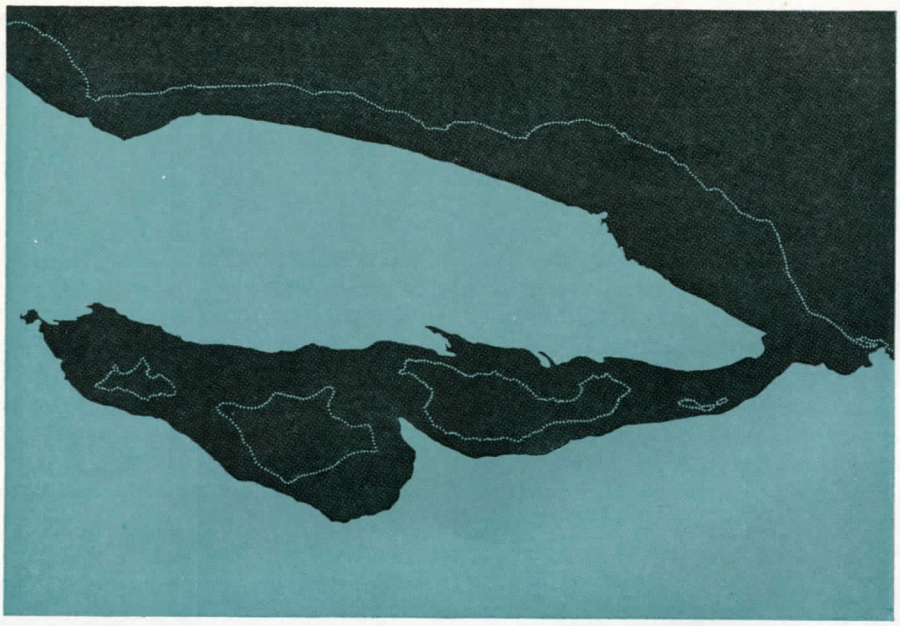
Careful comparisons of the skunks from the two islands reveal that there are differences between the populations, but these differences are not of the magnitude that would warrant their being placed even in different subspecies. One of the major differences is in total length, with those from Santa Cruz averaging 412 mm. and those on Santa Rosa averaging 426 mm.—about half an inch difference. All of the other differences between the two island populations are not consistent. For example, there is a significant difference in the height of the cranium between the males of the two islands, but not between the females; on the other hand, there is a significant difference between the females in length of head and body, a variant not true of the males.

To follow this thinking a little further, climate should be considered. After all, we have assumed that the skunks were on the islands during the last (and the previous) glacial periods. During the glacial periods of the Pleistocene, the climate on the Channel Islands probably was cool





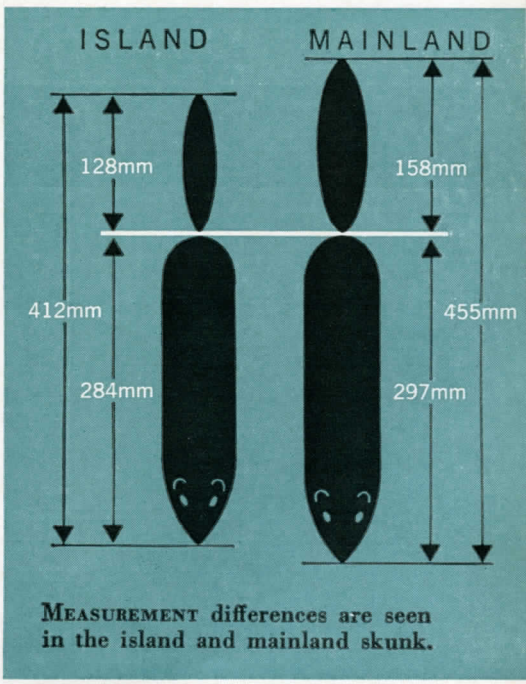
PROFILE shows three possible water levels—when sea was 300 feet above (A), where it is today (B), and 300 feet below contemporary level (C).



HYPOTHETICAL VIEW shows the Santa Barbara group of islands connected to each other and to mainland, *above*, as they probably were in an earlier epoch.

THREE ISLANDS remained connected to each other but were separated from coast by 10 miles of water. On modern maps islands appear approximately as below.

and moist, and in confirmation, evidence that Douglas fir—which thrives only in cool, moist areas—was present during this time has been found on Santa Cruz. After the last glaciation, the climate changed from cool and humid to the warm and arid condition that now obtains. It is therefore of interest to note that in its most distinctive characters (short tail, wide skull) the Channel Island spotted skunk resembles the subspecies (*S. putorius latifrons*) that is found in western Oregon and Washington, where the climate is still cool and moist. Such a resemblance could have occurred by chance, but it is also possible, and more likely, that it did not. For example, the Channel Islands could have been populated by animals with the characters of the Oregon–Washington skunks during a period of coolness and high humidity when *latifrons*-like skunks occurred (or had been forced down the coast by the severe climate) in the Santa Monica Mountains. When the climate became warmer, this mainland subspecies followed the cool, moist zone northward to its present location, while the Channel Island animals, being isolated, retained these characters or are still in the process of changing in response to the now-arid climate. There is also the possibility that the characters in which the Channel Island skunks resemble those of Oregon and Washington were evolved in response to the cool climate after the islands were separated from the mainland, and that they have either been



MEASUREMENT differences are seen in the island and mainland skunk.

retained or are still in the process of modification in response to the present warmth and aridity.

Differences in genetic composition provide the material for variation, and it is on such variation that evolution thrives. In a changing environment, those animals that have variations, however subtle, that give them a slight survival advantage over others will have a better chance to pass such attributes to their offspring. This is natural selection. The island skunks have been faced with a changing environment for the last 8,000 years. Unlike those on the mainland, they have not been able to escape it by moving, so they must adapt or die.

As a general rule, mammals respond to a warmer climate by increasing the size of their extremities. This is a mechanism by which an animal increases its surface area so that it may lose excess heat more rapidly. The length of the tail is one of the extremities that seems to respond to a warm climate by a size increase, and the idea that the Channel Island spotted skunks are in the process of modification receives some additional support from the study of tail length. In this character, the island spotted skunks show the highest degree of variation among some 2,000 specimens examined from all parts of the range. One would normally expect that the variation in such an inbred population as *amphiala* would be reduced, for there would be fewer genes for tail length in the population. With a smaller number of genes, the amount of variation would be limited. However, in length of the tail, the Channel Island skunks vary from 100 to 175 mm. (about 4 to 7 inches); the Washington–Oregon ones, from a much greater geographical area, vary only from 101 to 158 mm. (roughly a difference of 4 to 6 inches).

THE implication drawn from these data is that the spotted skunks on the islands were short-tailed during the cool periods of the last glaciation. Since then they have been evolving toward a longer tail—the normal response to a warm environment—but because they have not had the opportunity to come into equilibrium with the climate, they show great variability. The genes for short tails have not yet disappeared from the population.

Thus far, our hypothesis that the skunks walked to the Channel Islands seems acceptable, or at least the additional evidence available has done nothing to discredit it. There is, however, another bit of speculation. We have said that there are four islands in the Santa Barbara group, and that spotted skunks are found only on Santa Rosa and Santa Cruz. Why aren't they found on the other two islands, especially if, as we have said, the islands may at one time have formed a single unit separated by some miles of water from the mainland?

Anacapa is no problem. Actually, it is not a single island, but a string of several small islands extending for about five miles. The largest is less than a half mile wide and not quite two miles long; its elevation is 980 feet above the water level. By comparison, Santa Cruz is some twenty miles long and seven miles wide, and Santa Rosa is more than seventeen miles long and eleven miles wide. An individual spotted skunk will normally wander over an area of four square miles, so Anacapa is apparently just too small to support a skunk population.

Ordinarily San Miguel, the fourth island of the group, would seem to be an ideal place for skunks, because it does not differ much from Santa Rosa or Santa Cruz, except in size and conformation. San Miguel is about eight miles long and averages two miles in width, which should be sufficient to support a small skunk population. Its maximum elevation is, however, only 861 feet. During the fluctuations of water level and the uplift of land during the Pleistocene, there were times when large parts of the contemporary Channel Islands were below the surface of the water. This is indicated by the presence of sea shells of Pleistocene age high up on their slopes. If we raise the water level several hundred feet (or lower the islands—it doesn't matter which, in this case) the area of San Miguel available for inhabitation by spotted skunks would be greatly reduced; even at present its area is only 14,000 acres. Thus, during periods of submergence the spotted skunks might have been eliminated because the area was too small to support them, and they have not repopulated the island because they have been unable to cross the water barrier of 3½ miles separating San Miguel and Santa Rosa.

The theory to explain the presence of the animals on the Santa Barbara group, if correct, may lead to some conclusions on about how much evolution has taken place in spotted skunks. We may conclude that in one million years some slight but distinct differences have taken place between mainland and island skunks, and that these differences are sufficient to distinguish them on a weak subspecific level. During the 8,000 years that the two islands have been separated from each other, some differences have also developed between their respective skunk populations, but they are too slight to enable anyone to recognize

FOSSIL RECORD establishes that spotted skunks existed in Early Pleistocene, when they probably reached islands.

those on one island from those on the other with any degree of certainty. This would suggest that the rate of evolution in spotted skunks is not very rapid. Support for this contention also exists. In the Late Pliocene, some million years ago, there was a spotted skunk in Kansas; it is the oldest known spotted skunk, and yet it is almost identical with the pygmy skunk of today on the west coast of Mexico.

The reasons for this evolutionary rate are not known, but they are probably related to the skunks' unique defense, which enabled them to achieve a degree of stability in relation to the environments they faced during the Pleistocene. In addition, they are omnivorous, and thus are not especially affected by fluctuations in any specific kind of food. When vegetation is scarce they can feed on meat; when meat is in short supply they have insects, fruits, and berries for food. Thus they do not come into direct competition with many other kinds of animals and yet are adaptable enough in their food habits to take advantage of abundances. They can even store sizable amounts of food as body fat, which can carry them through a low food period or through weather so inclement that they cannot venture out to feed. It is probably through their adaptability and versatility that they have been able to survive with relatively little structural change over a period of many years.

The possibilities that the spotted skunks rafted to the islands or were carried by man cannot be discounted. In the absence of fossil skunks from the islands to establish their presence at an early date, a case can be made for each theory. The burden of evidence, however, fits the idea that they occupied the islands when there was a connection to the mainland; it is suited to the existing data, and does not require an accidental rafting or intentional or chance introduction by man.